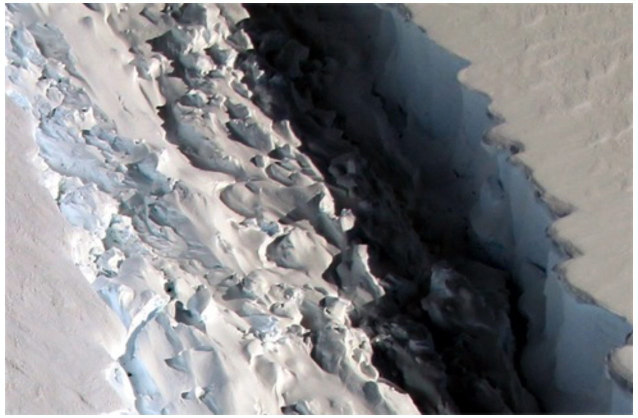
SCIENCE



Surface Biology and Geology Designated Observable

Kerry Cawse-Nicholson

Jet Propulsion Laboratory, California Institute of Technology

June 3, 2019




SBG Study Scope, Observation & Product Priorities Are Clear

- NASA/DS direction: SBG Shall Not Exceed $650 M total cost to NASA
- DS gave clear direction on SBG Observing priorities:
  - Terrestrial vegetation physiology, functional traits, and health
  - Inland and coastal aquatic ecosystems physiology, functional traits, and health
  - Snow and ice accumulation, melting, and albedo
  - Active surface changes (eruptions, landslides, evolving landscapes, hazard risks)
  - Effects of changing land use on surface energy, water, momentum, and C fluxes
  - Managing agriculture, natural habitats, water use/quality, and urban development
- SBG Science and Applications Traceability Matrices (SATM): ESAS and HyspIRI provide well-defined observables and products. The SATM will be finalized upon completion of sensitivity and simulation models.
- A diverse set of feasible, high value, observing architectures will be identified
- Develop a Value Framework to assess architectures against performance and cost effectiveness and risk posture, and down select to most desired
- Perform architecture in-depth design in preparation to support a MCR

SBG Organization, Roles & Work Flow Are Well-Defined

NASA HQ
Dave Jarrett
Woody Turner
Ben Phillips
Paula Bontempi

Center Executive Steering Committee
Ryan Spackman- NASA ARC
James Irons- NASA GSFC
Randy Friedl- JPL Chair
David Young- NASA LaRC
Gary Jedlovec- NASA MSFC

SBG Study Coordinator
Jamie Nastal- JPL

Research and Application Team
Dave Schimel- JPL, Coordinator
Betsy Middleton- GSFC
Science Steering Committee
Working Groups:
- Algorithms
- Cal/Val
- Modeling
- Applications
- Requirements & Traceability

Architecture Teams

Architecture Formulation Team
Kelley Case- JPL,
Co- Coordinator
Belgacem Jaroux- ARC,
Co-Coordinator

(A-Team Workshops for candidate architectures and detail architecture)

Phase 1: Identify Candidate Architectures
Tony Freeman- JPL, Lead
Ben Poulter- GSFC, Deputy Lead

Phase 2: Architecture Assessment
David Bearden- JPL, Lead
Jim Price- LaRC, Deputy Lead

Phase 3: Architecture Design
Amit Sen- JPL, Lead
Ben Poulter- GSFC, Deputy Lead

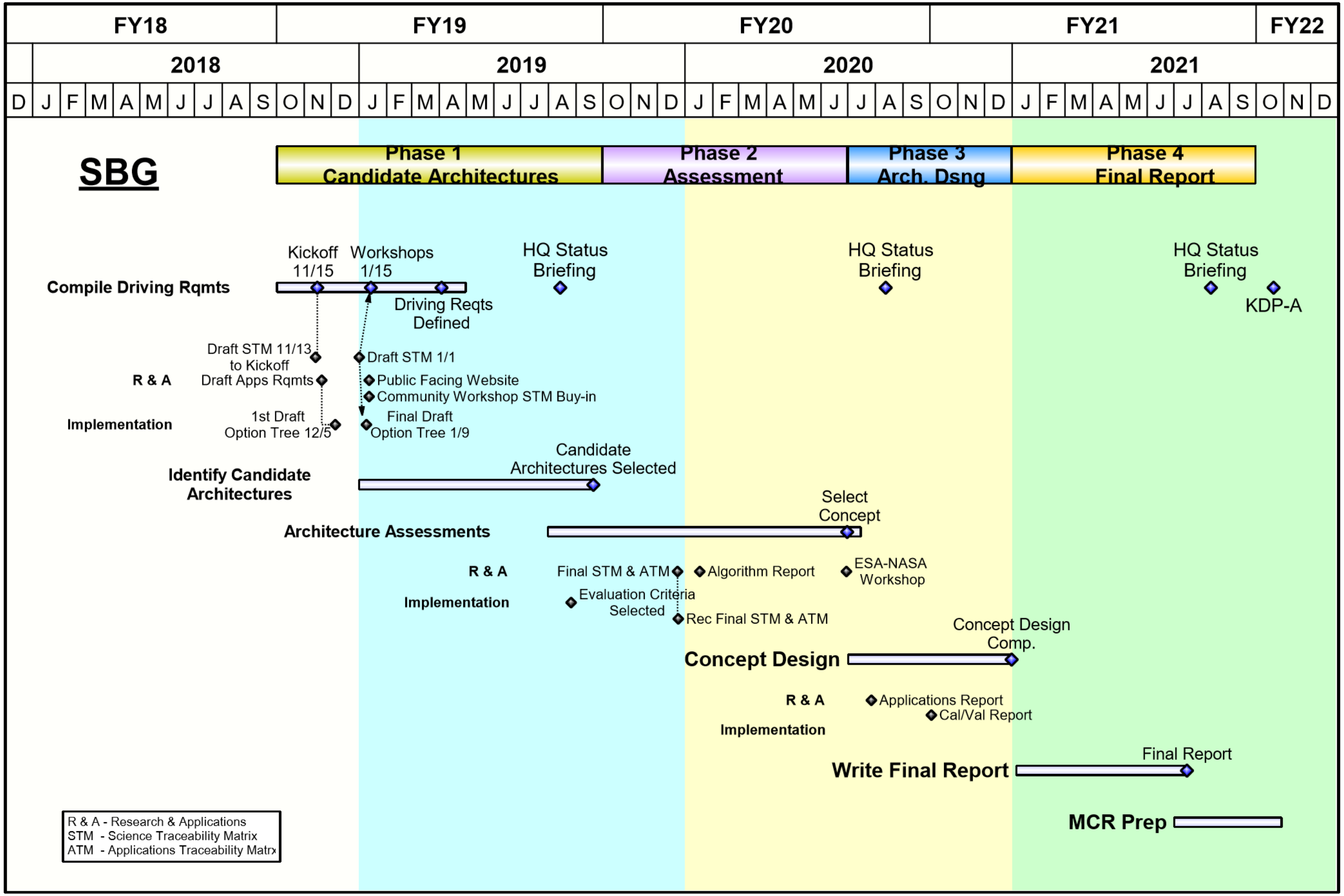
Cost Estimation Team
Jim Hoffman-JPL,
Co-Coordinator
Jordan Klovstad- ARC,
Co-Coordinator

Deliverable Preparation
Phase 4: Final Report, MCR material
Jamie Nastal- JPL, Lead

Working groups

- Algorithms
  - Phil Townsend, Kerry Cawse-Nicholson
- Applications
  - Jeff Luvall, Christine Lee, Nancy Glenn, Natasha Stavros
- Cal/Val
  - Kevin Turpie, Ray Kokaly
- Modeling
  - Ben Poulter, Shawn Serbin, Weile Wang

SBG Integrated Schedule Enables MCR/KDP-A in Fall 2021



SBG Science & Applications Objectives

Priority	Panel	Description
Most Important Objectives		
E1c	Ecosystems	Quantify the physiological dynamics of terrestrial and aquatic primary producers.
E2a		Quantify the fluxes of CO_2 and CH_4 globally at spatial scales of 100 to 500 km and monthly temporal resolution with uncertainty <25% between land ecosystems and atmosphere and between ocean ecosystems and atmosphere.
E3a		Quantify the flows of energy, carbon, water, nutrients, etc. sustaining the life cycle of terrestrial and marine ecosystems and partitioning into functional types.
H1c	Hydrology	Quantify rates of snow accumulation, snowmelt, ice melt, and sublimation from snow and ice worldwide at scales driven by topographic variability.
S1a	Solid Earth	Measure the pre-, syn-, and post-eruption surface deformation and products of Earth's entire active land volcano inventory at a time scale of days to weeks.
Very Important Objectives		
E1a	Ecosystems	Quantify the distribution of the functional traits, functional types, and composition of vegetation and marine biomass, spatially and over time.
H2a	Hydrology	Quantify how changes in land use, water use, and water storage affect evapotranspiration rates, and how these in turn affect local and regional precipitation systems, groundwater recharge, temperature extremes, and carbon cycling.
H4a		Monitor and understand hazard response in rugged terrain and land margins to heavy rainfall, temperature and evaporation extremes, and strong winds at multiple temporal and spatial scales. This socioeconomic priority depends on success of addressing H-1b and H-1c, H-2a, and H-2c.
S1c	Solid Earth	Forecast and monitor landslides, especially those near population centers.
S2b		Assess surface deformation (<10 mm), extent of surface change (<100 m spatial resolution) and atmospheric contamination, and the composition and temperature of volcanic products following a volcanic eruption (hourly to daily temporal sampling).
C3a	Climate	Quantify CO_2 fluxes at spatial scales of 100-500 km and monthly temporal resolution with uncertainty <25% to enable regional-scale process attribution explaining year-to-year variability by net uptake of carbon by terrestrial ecosystems (i.e., determine how much carbon uptake results from processes such as CO_2 and nitrogen fertilization, forest regrowth, and changing ecosystem demography.)
W3a	Weather	Determine how spatial variability in surface characteristics modifies regional cycles of energy, water and momentum (stress) to an accuracy of 10 W/m2 in the enthalpy flux, and 0.1 N/m2 in stress, and observe total precipitation to an average accuracy of 15% over oceans and/or 25% over land and ice surfaces averaged over a 100 × 100 km region and 2- to 3-day time period.

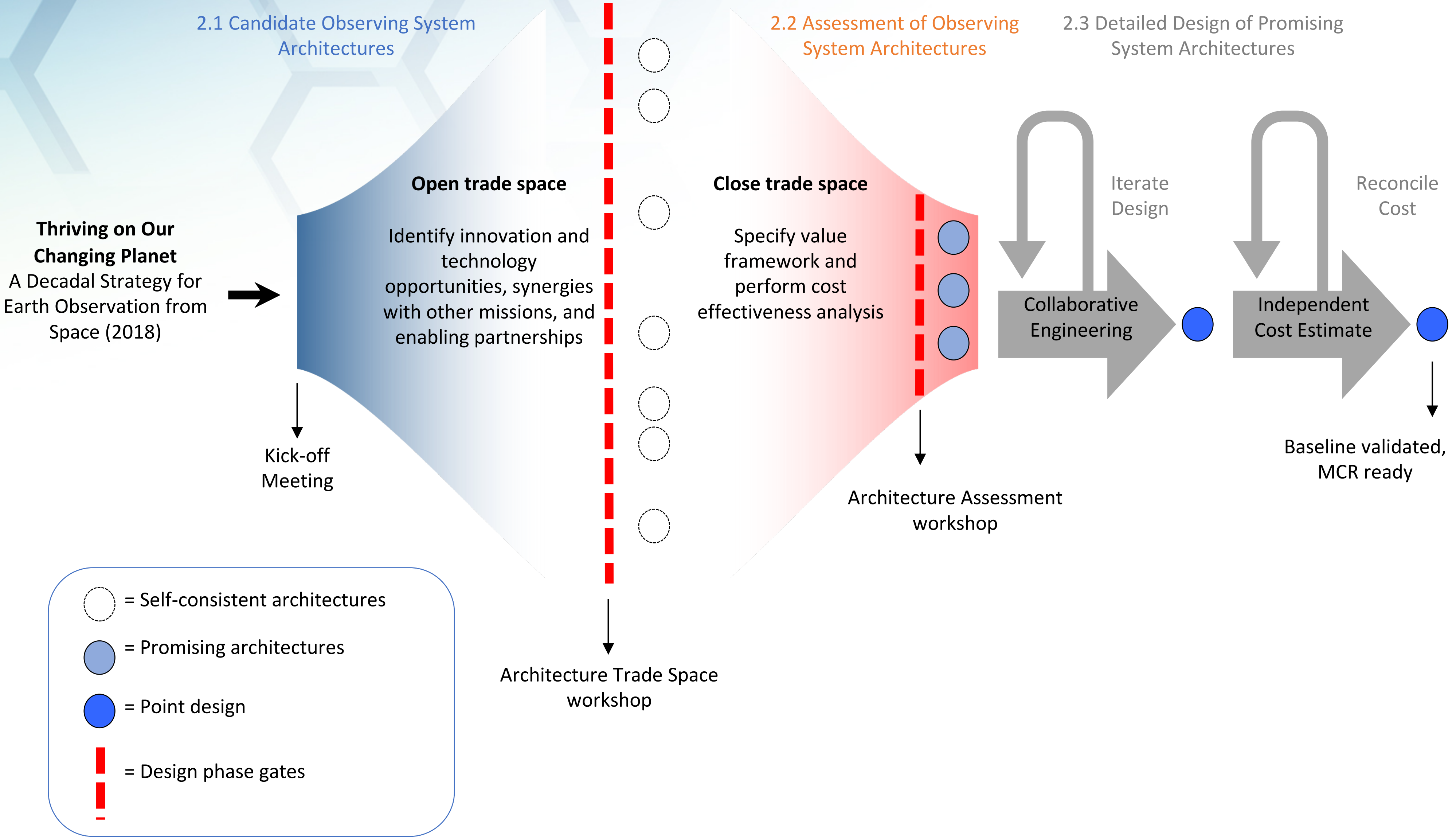
Sample products

Priority	Panel	Description
Most Important Objectives		
E1c	Ecosystems	Biochemical traits of aquatic biomass (including ocean color pigmentation and coastal productivity) Phytoplankton functional type Benthic composition (coastal) Chemical properties of canopies Soil properties Terrestrial veg functional traits, types, composition Terrestrial veg species
E2a		
E3a		Non-photosynthetic vegetation
H1c	Hydrology	Snow and ice coverage fraction (cryosphere) Snow spectral albedo (cryosphere) Snow surface temperature (cryosphere)
S1a	Solid Earth	Land surface temperature (active volcanoes) Fractional coverage and silicate composition of lava flows, ash deposits (active volcanoes) Gas and particle concentrations (active volcanoes) Surface composition of vegetation, rock and soils

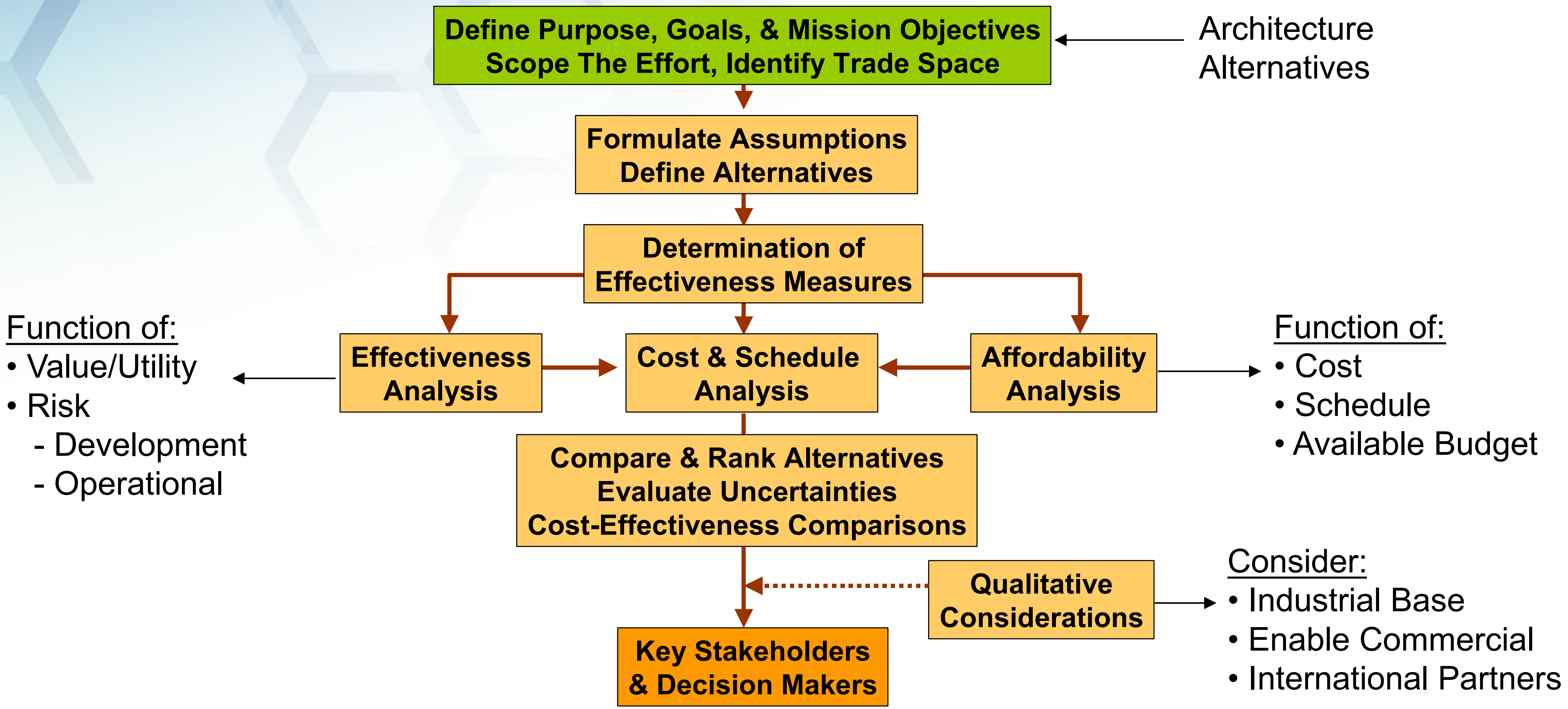
Sample products

Priority	Panel	Description
Very Important Objectives		
E1a	Ecosystems	Biochemical traits of aquatic biomass (including ocean color pigmentation and coastal productivity) Phytoplankton functional type Benthic composition (coastal) Chemical properties of canopies Soil properties Terrestrial veg functional traits, types, composition Terrestrial veg species
H2a	Hydrology	Reflectance and emissivity Evapotranspiration Surface temperature
H4a		Snow and ice coverage fraction (cryosphere) Snow spectral albedo (cryosphere) Snow surface temperature (cryosphere)
S1c	Solid Earth	Surface composition of vegetation, rock and soils
S2b		Land surface composition and temperature (active volcanoes)
C3a	Climate	
W3a	Weather	Land surface temperature

Evolution of a concept

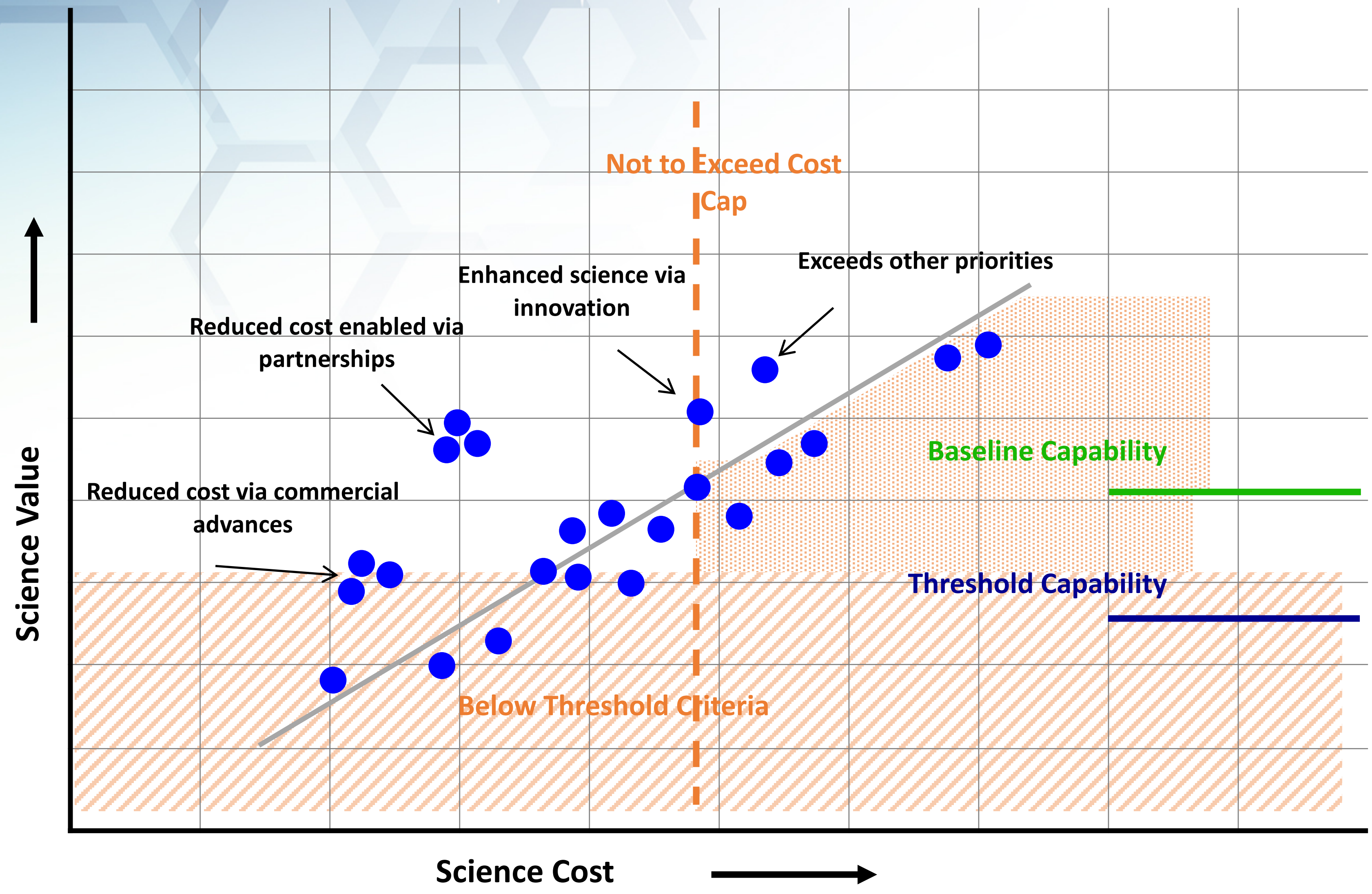


Assessment process



Once a set of system architectures has been identified, a Value Framework will be established. A set of measures of effectiveness (MOEs) will be defined based on the ESAS 2017 DS. Measures of Effectiveness will be developed to assess the key features relevant to decision criteria while providing the ability to discriminate between alternatives. The alternatives will then be evaluated through a set of analyses covering such assessment areas as capability, cost, schedule, risk, and affordability.

Value framework assessment



Notional graphic showing Science Value vs. Cost. Gray diagonal line depicts a conventional cost performance profile. Blue dots depict individual architectures. Reduced cost to NASA may be enabled through strategic partnerships and/or innovative opportunities. Enhanced science return may be enabled through new technologies and/ or innovation. Architectures below the Threshold mission or above the cost target will not be considered.

Next steps

- Community workshop in Washington DC 12-14 June
- Finalizing initial SATM, required product list, and available architectures by September (end of Phase 1)
- Phase 2: evaluation of architectures using the value framework

Jet Propulsion Laboratory
California Institute of Technology

jpl.nasa.gov